# Construction Completion Report Globeville Landing Outfall Project Removal Action

# Vasquez Boulevard/Interstate 70 Site, Operable Unit 2

Prepared for:

**City and County of Denver**
**Environmental Quality Division**
**101 West Colfax Avenue, Suite 800**
**Denver, CO 80202**

Prepared by:

**Engineering Management Support, Inc.**
**25923 Gateway Drive**
**Golden, Colorado 80401**

January 15, 2020

**City and County of Denver Certification Statement:**

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

**City and County of Denver Project Manager:** ______________________________

Agatha Linger

**Date:** January 15, 2020

**REVIEWED AND APPROVED BY:**

**USEPA Remedial Project Manager:** ______________________ 2020-01-22

Jesse Aviles Date

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## LIST OF ACRONYMS

| | |
|---|---|
| ACM | Asbestos-Containing Material |
| Amec Foster Wheeler | Amec Foster Wheeler, plc. |
| AOC | Agreement and Order on Consent |
| bgs | Below ground surface |
| BMPs | Best Management Practices |
| CCD | City and County of Denver |
| CCR | Construction Completion Report |
| CDPHE | Colorado Department of Public Health and Environment |
| CDOT | Colorado Department of Transportation |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act |
| COC | Compound of Concern |
| CQA | Construction Quality Assurance |
| DADS | Denver Arapahoe Disposal Site |
| ELLS | Electric Leak Location Survey |
| EMSI | Engineering Management Support, Inc. |
| EPA | Environmental Protection Agency |
| GLO | Globeville Landing Outfall |
| GLOEMMP | Globeville Landing Outfall Environmental Monitoring and Maintenance Plan |
| HASP | Health and Safety Plan |
| Hayward Baker | Hayward Baker, Inc. |
| Kleinfelder | Kleinfelder, Inc. |
| MFEI | McDonald Farms Enterprises, Inc. |
| mg/kg | milligram per kilogram |
| MMP | Materials Management Plan |
| MODCP | Methane, Odor, and Dust Control Plan |
| NAAQS | National Ambient Air Quality Standards |
| NCR | Non-Compliance Report |
| OU2 | Operable Unit 2 |

| | |
|---|---|
| OSC | On-Scene Coordinator |
| OSHA | Occupational Safety and Health Administration |
| QA | Quality Assurance |
| RACS | Regulated Asbestos-Containing Soil |
| RA | Removal Action |
| RAWP | Removal Action Work Plan |
| RCB | Reinforced Concrete Box |
| RPM | Remedial Project Manager |
| RTD | Regional Transportation District |
| SOW | Statement of Work |
| VOCs | Volatile Organic Compounds |
| WET | Whole Effluent Toxicity |
| WM | Waste Management |

# 1 INTRODUCTION

This Construction Completion Report (CCR) was prepared on behalf of the City and County of Denver (CCD) pursuant to Section II.7 of the Statement of Work (SOW) attached to the Administrative Settlement Agreement and Order on Consent (AOC) for Removal Action in a Proceeding Under Sections 104, 106(a), 107 and 122 of the Comprehensive Environmental Response, Compensation, and Liability Act, 42 U.S.C. §§ 9604, 9606(a), 9607 and 9622 regarding the Vasquez Boulevard/Interstate 70 (VB/I70) Site Operable Unit 2 (OU2).

## 1.1 Operable Unit Background

OU2 is generally bounded by I-70 on the north, the South Platte River on the west, Brighton Boulevard on the east, and Globeville Landing Park and property owned by Pepsi Bottling Company on the south. As shown on Figure 1, the Globeville Landing Outfall (GLO) Project (the Site) is located within OU2. The GLO Project is the furthest downstream component of a larger drainage project in north Denver that is intended to reduce flooding in the Montclair Drainage Basin area and address stormwater management needs in coordination with projects being developed by the Regional Transportation District (RTD), Colorado Department of Transportation (CDOT), and the CCD.

Work under the Removal Action entailed implementation of the "environmental components" of the GLO Project. The "environmental components" are limited to:

- Management and handling of waste material encountered during construction of the GLO Project within the Denver Coliseum (Coliseum) parking lot and Globeville Landing Park;
- Mitigation of methane gas, odors, and fugitive dust that may be released during construction;
- Construction of an impermeable barrier system to prevent contaminants remaining within the boundaries of OU2 from adversely impacting stormwater retained within, and conveyed by the GLO Project, as well as prevent stormwater infiltration into contaminated media remaining beneath or surrounding the GLO Project; and
- Management and treatment of dewatering liquids produced during construction of the GLO Project.

The purpose of this CCR is to document completion of the "environmental components," hereinafter referred to as the Removal Action, in accordance with EPA-approved plans and design documents. Specifically, the following plans and design documents were applicable to implementation of the Removal Action:

- **Removal Action Work Plan,** High Street Outfall and 40th Avenue Storm Sewer System, Vasquez Boulevard/Interstate 70 Site, Operable Unit #2, prepared by Engineering Management Support, Inc., June 19, 2015. Note: A

**Sampling and Analysis Plan** for the Design Investigation was included as Appendix C to the Removal Action Work Plan.

- **Health and Safety Plan** for the Removal Action, High Street Outfall and 40th Avenue Storm Sewer System, Vasquez Boulevard/Interstate 70 Site, Operable Unit #2, prepared by Engineering Management Support, Inc., June 19, 2015.

- **Data Summary Report,** Environmental Conditions Investigation High Street Outfall and 40th Avenue Storm Sewer System, Vasquez Boulevard/Interstate 70 Site, Operable Unit #2 Removal Action, prepared by Engineering Management Support, Inc., September 18, 2015.

- **Addendum 1 to Data Summary Report,** Environmental Conditions Investigation High Street Outfall and 40th Avenue Storm Sewer System, Vasquez Boulevard/Interstate 70 Site, Operable Unit #2 Removal Action, prepared by Engineering Management Support, Inc., March 15, 2016.

- **Methane, Odor, and Dust Control Plan,** Globeville Landing Outfall Project, prepared by Engineering Management Support, Inc., December 15, 2015.

- **Materials Management Plan,** Globeville Landing Outfall Project, prepared by Engineering Management Support, Inc., January 25, 2016.

- **Final Design Report**, Environmental Components for Globeville Landing Outfall Project, prepared by Engineering Management Support, Inc., R.K. Frobel & Associates, LLC, and Itasca Denver, Inc., February 5, 2016.

- **Addendum 1 to Final Design Report**, Environmental Components for Globeville Landing Outfall Project, prepared by Engineering Management Support, Inc. and Itasca Denver, Inc., August 5, 2016.

- **Addendum 2 to Final Design Report**, Environmental Components for Globeville Landing Outfall Project, prepared by Engineering Management Support, Inc., November 28, 2016.

- **Addendum 3 to Final Design Report**, Environmental Components for Globeville Landing Outfall Project, prepared by Engineering Management Support, Inc., April 12, 2018.

## 1.2 Project Organization

A project Organization Chart for the Removal Action is shown on Figure 2. Overall, the project was managed by its project coordinators, Ms. Jennifer Luthi, Ms. Kara Edewaard, and Ms. Agatha Linger from the CCD. These professionals represented the interests of the CCD and were responsible for ensuring that all aspects of the work described in the SOW were implemented in accordance with the AOC. They had direct reporting responsibility to the EPA and other entities involved with the GLO Project.

The CCD retained Engineering Management Support, Inc. (EMSI) as the Managing Contractor. All aspects of the work performed by the CCD pursuant to the AOC were under the direction and supervision of EMSI. Accordingly, EMSI and its subcontractors (discussed below) witnessed and provided Quality Assurance (QA) for all aspects of the Removal Action. To facilitate this, the project coordinators authorized EMSI to communicate directly with the construction contractor, EPA, and other regulatory entities on their behalf.

EMSI retained six key subcontractors. R.K Frobel and Associates, LLC was retained as the QA Official for the impermeable liner. Itasca-Denver was retained for groundwater modeling and dewatering expertise. Higgins and Associates, LLC and Matteocci & Associates, LLC were retained to monitor and audit compliance with asbestos management activities for consistency with Section 5.5 of Colorado's Solid Waste Regulations (CSWRs), and environmental monitoring activities prescribed in the Methane, Odor, and Dust Control Plan (MODCP) (EMSI, 2015d) and Materials Management Plan (MMP) (EMSI, 2016a). TestAmerica Laboratories, Inc. was retained for analyses of soil samples to ensure that on-Site soils reused on-Site complied with EPA/CDPHE cleanup action levels, as discussed in Addendum 2 to the Final Design Report (EMSI, 2016e). Lastly, Site Services Drilling, LLC was retained to drill soil borings, collect soil core, and install temporary piezometers where required.

Construction was performed by Ames Construction, Inc. (Ames), who was a prime subcontractor to Kiewit Infrastructure Company (Kiewit), who in turn, served as CCD's Integrating Contractor for the Montclair Drainage Basin projects. Ames was responsible for construction of the entire GLO Project, which included the Removal Action. EMSI coordinated with Ames regarding the environmental components of the GLO Project. Ames retained six key subcontractors to perform Removal Action work. They consisted of:

- **Earth Services and Abatement, Inc.**, who provided excavation, loading, and transport of asbestos-containing materials and waste soil and debris to the Denver Arapahoe Disposal Site (DADS);

- **Kleinfelder, Inc. (Kleinfelder)**, who provided environmental monitoring and permitting services;

- **Hayward Baker, Inc. (Hayward Baker)**, who installed compaction grout columns and vibration stone columns to stabilize waste material beneath the stormwater conveyance features;

- **ECApplications, Inc.**, who installed the geocomposite liner system;

- **Amec Foster Wheeler, plc. (Amec Foster Wheeler)**, who provided construction QA for the liner installation; and

- **McDonald Farms Enterprises, Inc. (MFEI)**, who provided transport and off-Site treatment of dewatering waters from the Site.

## 1.3 Report Organization

This CCR contains eight sections, including this introduction. Descriptions of construction activities, any deviations, and a chronology of construction events are presented in Sections 2 and 3, respectively. Section 4 contains performance standards and construction quality control information. Section 5 describes results of various inspections, including the Pre-Final Inspection, identifies any deficiencies, and summarizes post-removal site controls. Section 6 presents final costs for the Removal Action and Section 7 provides contact information for CCD's current project coordinator, EMSI, the liner designer and QA officer, construction contractor, EPA, and CDPHE. Lastly, a list of references is provided in Section 8.

The text and figures are followed by three appendices that contain:

Appendix A: Record Drawings
Appendix B: Waste Manifest Summary
Appendix C: Construction Quality Assurance Reports

## 2 CONSTRUCTION ACTIVITIES

Construction activities consisted of:

- Environmental Monitoring and Health and Safety;
- Mobilization and Site Preparation;
- Stormwater Management;
- Subsurface Soil Stabilization;
- Excavation and Materials Handling;
- Dewatering and Water Treatment; and
- Impermeable Barrier Installation and Testing.

Each activity is discussed below, including any deviations from the Final Design Report (EMSI, 2016b). Record drawings for Removal Action components are presented in Appendix A.

### 2.1 Environmental Monitoring and Health and Safety

On-Site monitoring for volatile organic compounds (VOCs) (including methane), odor, and visible dust emissions occurred continuously during excavation and drilling activities. In addition, when Regulated Asbestos-Containing Soils (RACS) were encountered and disturbed, monitoring for airborne asbestos fibers proceeded in accordance with Section 5.5 of the CDPHE Solid Waste Regulations.

Off-Site monitoring by the CCD for $PM_{10}$, and airborne lead and arsenic occurred prior to and throughout construction from December 2016 through August 2018. $PM_{10}$ describes inhalable particles, with diameters that are generally 10 micrometers and smaller. Sampling was performed at four locations; two within OU2 and two just outside the OU2 boundary on the west side of the South Platte River. Sampling occurred every sixth day throughout each month. Per an agreement made between EPA and CCD in January 2018, 3 of the 4 air monitors had to be functioning properly for the monitoring event to be considered successful. If two monitors malfunctioned during the sampling event, all monitors were to be resampled as soon as possible. No monitoring events occurred where 2 or more monitors failed.

All $PM_{10}$ results were below the EPA National Ambient Air Quality Standard (NAAQS) for a 24-hour sampling interval (150 micrograms per cubic meter ($\mu g/m^3$)), with the exception of one sampling day. On January 8, 2018, a high air pollution day was observed in the Denver and Commerce City areas. High clouds for much of the day, a shallow mixed layer or temperature inversion, calm/light winds, and typical urban emissions all combined to create this episode. The arsenic and lead results never exceeded the Occupational Safety and Health Administration (OSHA) 8-hour limit (10 $\mu g/m^3$ and 50 $\mu g/m^3$, respectively), nor the NAAQS lead rolling 3-month average of 0.15 $\mu g/m^3$.

In addition to environmental monitoring, on-Site workers were required to comply with Health and Safety Plans (HASPs) prepared by Ames and Kiewit. Both of their HASPs met the requirements of the HASP prepared by EMSI (EMSI, 2015b), that established the minimum regulatory requirements for the Removal Action.

## 2.2 Mobilization and Site Preparation

A temporary field office was established for on-Site management of the Removal Action. The field office was equipped with potable bottled water, a fire extinguisher, a safety door, and fire and smoke detectors. Electric service was provided from a Coliseum power supply designated by the CCD.

Lighting was provided for all work areas when night work was required, or natural light was inadequate to perform work safely. Work areas were lighted to not less than the minimum illumination intensities listed in OSHA Standard 29 CFR 1910.120.

Ames supplied construction water from a Denver Water fire hydrant equipped with a water meter. That water was used for odor and dust suppression, and soil moisture conditioning.

All vehicular traffic control conformed to a traffic pattern that was agreed to by the CCD and complied with Site Rules (discussed below) to promote safe and efficient operations. Parking areas were designated by Ames' on-Site project manager. Site Rules were as follows:

- Maximum speed limit for all vehicles/equipment on-Site was 15 miles per hour;
- Vehicle and pedestrian traffic yielded to heavy equipment at all times;
- Contractors' vehicles displayed orange survey flagging wrapped around the interior rear-view mirror to distinguish them as Superfund Site activity-related vehicle traffic; and
- No vehicle was allowed to idle for more than 5 minutes (Title II – Revised Municipal Code, Chapter 4, Article IV, Sec 4-43) unless it was required to perform a specific construction function.

Security fencing was set up around work areas with entrance and egress points.

## 2.3 Stormwater Management

Ames developed a stormwater control plan as a contract deliverable. The plan detailed means and methods to divert stormwater around open excavations, haul roads, storage areas, and administrative offices. Diversions consisted of berms and interceptor channels that routed stormwater to the South Platte River with minimal erosional impact. To the extent that the diverted stormwater contained suspended solids contributed from Site activities, the diverted water was treated using Best Management Practices (BMPs) prior to release to the South Platte River. Such BMPs consisted of hay/straw bales and silt fencing composed of geotextile.

Stormwater that made contact with waste material was collected and treated under the project's Colorado Department of Public Health and Environment (CDPHE) Discharge Permit Number CO0049002 prior to release to the South Platte River.

## 2.4 Subsurface Soil Stabilization

After mobilization and Site preparation, two types of subsurface soil stabilization columns were installed; compaction grout columns and stone columns. Compaction grout columns were installed to stabilize waste material below the Reinforced Concrete Box (RCB) conduit through the Coliseum parking lot. Stone columns were installed to stabilize waste material below the open channel through the parking lot. General areas where both types of columns were installed are shown on Figure 1. Detailed locations are shown on record drawings EC-4 and EC-5, and REF 10 through REF 16 (Appendix A).

Compaction grout columns were installed pneumatically by driving injection piping down to firm soil or bedrock and then injecting cement grout. During injection the grout displaced the soft waste material resulting in densification of the surrounding materials. Column placement involved primary and secondary types, both on 8-foot centers. As shown on record drawings EC-4, EC-5, and EC-6, this resulted in net spacings of 4 feet on-center. The finished (top) elevations of the grout columns were established at the bottom elevation of the RCBs, such that when constructed, the bottom of the RCBs would rest directly on the grout columns. The total number of grout columns installed was 1,083.

Stone columns were installed using a down hole vibrator and tremie pipe to advance the crushed rock (gravel) to the bottom of the stone column. Placement of the aggregate was done in 12-inch lifts while continuing to vibrate the material in place. This resulted in densifying and laterally displacing the aggregate. Spacing of stone columns was on 8-foot centers, as shown on record drawings EC-4, EC-5, and EC-6. The finished (top) elevations of the stone columns were established at the bottom elevations of the strengthening layer underlying the impermeable liner system, such that the strengthening layer would rest directly on the stone columns. The total number of stone columns installed was 593.

## 2.5 Excavation and Materials Handling

Following installation of the grout and stone columns, excavation of overburden from the Coliseum parking lot and Globeville Landing Park commenced down to base grade elevations prescribed on the construction drawings. Areas where over-excavations occurred down to structural subgrade were then backfilled with clean soils to final grade are shown on Figure 3 and REF 04 (Appendix A). This figure is offered for Park maintenance personnel who may need to excavate for irrigation lines, tree plantings, or other purpose. Figure 4 summarizes areas and depths of cut and fill from existing grade to final grade for the GLO Project (note: this figure does not include the depth of removal for over-excavation areas).

Earthwork involved a coordinated effort among earth moving operators and hazardous material competent persons, the latter of whose qualifications included certified asbestos building inspector (CABI), to observe the material being exposed. The competent persons were equipped with instrumentation that could monitor changes in the waste stream for organic compounds and asbestos-containing material (ACM), and identify potentially hazardous wastes if encountered.

At the direction of the competent persons, overburden material was segregated into three categories: material determined to be RACS; material determined to be non-RACS that could not be reused on-Site; and material determined to be non-RACS that could be reused on-Site. Determinations were made in accordance with criteria described in the MMP (EMSI, 2016a).

Each material type was handled separately. For example, RACS was excavated and direct-loaded into lined haul trucks and transported to DADS. Non-RACS that could not be reused on-Site was direct-loaded into unlined haul trucks and transported to DADS. All loads to DADS were accompanied by shipping manifests that described the material type and volume which allowed for proper assignment to designated disposal cells. Totals of 107,671 cubic yards of RACS material and 53,421 cubic yards of non-RACS that could not be reused on-Site were hauled to and disposed at DADS. A summary of shipping manifests is presented in Appendix B. It should be noted that the total volumes listed above and those calculated from the manifest summaries differ because a fully-loaded truck could only carry about 14 cubic yards due to volume limitations, whereas each load ticket at DADS' entrance gate was listed at 17 cubic yards regardless of actual volume, per the CCD's operating agreement with Waste Management of Colorado, Inc.

Non-RACS material that could be reused on-Site was temporarily staged on-Site for later reuse as subsurface backfill material. A total of 13,116 cubic yards of this type of material was stockpiled and reused.

Most of the overburden down to approximately 10 feet below ground surface (bgs) in the Coliseum parking Lot, and down to approximately 15- 20 feet bgs in the Globeville Landing Park was sufficiently dry to excavate without dewatering. However, where perched groundwater was encountered, the saturated overburden was placed in the open excavation and allowed to gravity-drain. The dewatered material was then managed as unsaturated soil or waste material.

As excavation advanced deeper into the groundwater table, dewatering became necessary. Dewatering details are discussed in the next subsection. As dewatering lowered the water table, free liquids gravity-drained from most of the overburden. In cases where it did not, the material was moved to higher elevations within the open excavation and allowed to gravity-drain until it became unsaturated.

## 2.6 Dewatering and Water Treatment

Effective dewatering, treatment, and management of treated water were large components of the Removal Action. The following paragraphs present the dewatering approach implemented by Ames. Conceptual layouts for each dewatering zone are shown on record drawing EC-2 and discussed below. Note: Groundwater elevations are shown on many of the record drawings – they are based on pre-construction elevations prior to dewatering and are generally higher than post-construction elevations. Groundwater elevations will be provided as part of annual GLO monitoring and maintenance reports.

### 2.6.1 Dewatering

**Zones 1 and 2**

Dewatering Zones 1 and 2 were protected with sheet piles driven to and keyed into bedrock: a) along the western boundary of Zone 1 (adjacent to the South Platte River) to minimize inflow from river alluvium; and b) around the northern, eastern, and southern perimeters of Zone 2 to stabilize excavation sidewalls and minimize lateral inflow while the box culvert and drop inlet and outlet structures were constructed. Under these conditions, dewatering utilized lateral trench drains connected to several wet wells from which groundwater was extracted. At completion of construction the sheet piles were removed and the lateral drains and wet wells were deactivated and abandoned.

In general, this dewatering approach worked well, but within Zone 2, a gravel underdrain beneath the western sanitary sewer line was encountered that was not anticipated. The underdrain conveyed a large amount of flow from the south (upgradient direction). When the underdrain was exposed, flow entered the Zone 2 work area, requiring excessive pumping to maintain dry working conditions. To reduce inflow, the underdrain was temporarily plugged. After the box culvert beneath the sanitary sewer was constructed, a 10-inch diameter PVC pipe was installed parallel to and at an elevation beneath the sewer to restore subdrain flow to the north (downgradient direction). EPA verbally approved the diversion piping. The alignment is shown on Sheet 29 of the record drawings.

**Zone 3a**

In Zone 3a, dewatering was to be accomplished with parallel trench drains connected to a common wet well. However, when overburden was removed, a large deposit of clean sand was discovered below the water table that served as a natural drain medium. Consequently, and as shown on record drawing EC-2, only two trench drains were installed with each connected to a wet well. The drains and wet wells remained functional during overburden removal and construction of the open channel through the Globeville Landing Park, lateral drain boxes, inlet drop structure, and strengthening layer. They were deactivated and abandoned following construction of the strengthening layer.

An unforeseen condition was encountered in this zone that created a high inflow of groundwater. There was an apparent hydraulic connection between the former Arkins Court outfall and/or groundwater migrating beneath it, and the permeable alluvial deposits beneath Zone 3a. Surface water from the outfall and/or groundwater from beneath it acted as a constant source of recharge to the sands beneath Zone 3a. This, in turn, caused flooding problems within the zone, despite high pumping rates from the wet well. To correct this problem, temporary sheet piles was installed along the southern side of the open channel. Their alignment is shown on Figure 5 and Sheet 12 of the record drawings. Surveyed coordinates are shown on REF 01 of the record drawings. The sheet piles were driven through saturated sands and gravels to several feet into underlying bedrock. Laterally, they were locked together to create a relatively impermeable subsurface barrier along the entire alignment. The sheet-pile wall was successful at reducing total inflows and lowering the water table beneath the open channel in Zones 3a and 3b to several feet beneath the strengthening layer.

Monitoring for a rise in the water table upgradient (south) of the sheet pile wall was initiated immediately following its installation. A rise began within days following installation, but leveled off after several weeks to a steady-state rise of two-to-three feet above pre-wall levels, depending on location. This rise was determined to have minimal environmental consequence because the depth to groundwater in the impacted area remained at 8 to 15 feet below the ground surface. In addition, there was no apparent increase in discharge areas, i.e., new seeps or areas of surface saturation, along the eastern bank of the South Platte River.

While the strengthening layer was being installed, an evaluation was conducted to assess whether the temporary sheet piling should remain in place permanently to protect the long-term integrity of the liner system. The evaluation also assessed whether the check dam within the strengthening layer between dewatering Zones 3a and 3b would be necessary, given the new understanding of the Site hydrogeology. Both of these issues were addressed in Addendum 3 to the Final Design Report (EMSI, 2018a). Potential long-term impacts to the South Platte River with or without the sheet piles in place were also addressed in Addendum 3. The following conclusions and recommendations were offered in the Addendum:

1. If sheet piling along the southern boundary of the GLO project is left in place, the design minimum factor of safety (FOS) for the liner design of 150% will be maintained. If sheet piling is removed, the FOS may decline to less than 150% beneath parts of the liner.

2. Modeled changes in the hydrogeologic units and hydraulic property values in the vicinity of the liner system render the check dam in the strengthening layer ineffectual at limiting preferential flow of groundwater toward the South Platte River with or without the sheet piles in place.

3. If the sheet piles remain in place, modeling indicated a reduction in water table elevations downgradient from the sheet piles. An associated reduction in saturated thickness means there should be less groundwater flux through fill in the part of the Coliseum parking lot that is downgradient from the sheet piles.

4. Model results indicated that the groundwater flux from fill beneath the Coliseum parking lot could increase following completion of the Removal Action, regardless of whether sheet piles are left in place. However, an increase of 6 gallons per minute (gpm) with the sheet piles in place, versus 11 gpm with the sheet piles removed represents only 2 to 4 percent, respectively, of the simulated net groundwater discharge to the South Platter River within the model domain (approximately 264 gpm). These differences were considered negligible.

5. Potential water quality impacts (lead and arsenic) to the South Platte River would be

inconsequential, regardless of whether the sheet piles are left in place.

In conclusion, the CCD determined there was net positive impact to the Removal Action, and the environment in general, by leaving the sheet piles in place. In addition, with the sheet piles in place, the check dam would no longer be useful. Consequently, the CCD recommended, and EPA and CDPHE accepted, a decision to leave the sheet piles in place and not install in the check dam.

**Zone 3b**

In Zone 3b, dewatering was accomplished with two parallel gravel drains connected to a common wet well. The drain/wet well system functioned as intended to maintain dry working conditions. This condition was helped by the presence of the sheet piles discussed above. The dewatering system continued to operate as the strengthening layer was installed, then was abandoned in place.

**Zone 4**

Dewatering from Zone 4 was not necessary because the base elevation of the RCB conduit in the Final Design documents was established at an elevation above the pre-construction water table.

### 2.6.2 Water Treatment

Total flow rates from dewatering activities ranged from approximately 10 gpm to 120 gpm, depending on which dewatering zones were operating and placement of sheet piling. Extracted water was pumped to two 20,000 gallon frac tanks located on-Site. MFEI, the water treatment contractor, pumped water from the frac tanks into their transport trucks and hauled it to their treatment facility at 4647 National Western Drive, Denver, Colorado – approximately 0.35 miles from the Site. There, the water was treated and released to the South Platte River under CDPHE Discharge Permit Number CO0049002. Approximately 31.1 million gallons of water were treated and released.

## 2.7 Impermeable Barrier Installation and Testing

The impermeable barrier system was constructed in accordance with the Final Design Report Plans and Specifications (EMSI, 2016b), with the single exception that the check dam within the strengthening layer was omitted, as discussed above. Typical cross-sections of the barrier system are shown on record drawing EC-7. From bottom up, barrier system components consist of a geogrid base layer (Tensar TX), strengthening layer (Class 57 coarse concrete aggregate and top geogrid), impermeable barrier (bottom 16 oz geotextile, middle 60 mil textured geomembrane, top geonet composite) and overlying protective soils. Above the protective soils, a highly visible orange polyethylene construction fencing was placed to mark the top of the protective soil layer. Material specifications and placement details conformed to the construction specifications, as witnessed by the QA officer (R. Frobel).

Construction Quality Assurance (CQA) testing and an electrical leak location survey (ELLS) were conducted following placement of the liner system (with overlying protective soils), and following repair of a soil erosion event at the Arkins Court outfall in June 2018 (discussed below). CQA and ELLS reports for the initial liner installation, and an ELLS report for the erosion repair are presented in Appendix C and discussed below.

**<u>Initial Barrier System Installation</u>**

Amec Foster Wheeler provided CQA testing of the liner and confirmed the impermeable barrier and overlying soils were constructed in accordance with the construction drawings and specifications, with one exception. The liner anchoring, as shown on record drawing EC-8, was proposed to be a minimum height of 12 inches from the subgrade surface. However, during installation this requirement was changed to a minimum of 8 inches because some of the open channel wall footings were less than 12 inches high. The liner designer and QA officer (R. Frobel) accepted this exception. Mr. Frobel also confirmed Amec Foster Wheeler's statement that the liner was installed in accordance with the construction drawings and specifications.

Leak Locations Services, Inc. conducted the ELLS. Due to the concrete walls and the batten bars creating electrical interference with the test, a leak detection sensitivity test was conducted prior to performing the survey. The survey was performed within general accordance to ASTM D7007. A report detailing the ELLS method and conclusion of "no leaks discovered" is appended to the Amec Foster Wheeler report in Appendix C.

For future reference, wire leads for ELLS testing are accessible from two locations. One is from a plastic control box positioned adjacent to the northwestern edge of the grouted rip-rap apron to the RCB conduit outfall in the Coliseum parking lot. The other is from a plastic control box positioned adjacent to the western edge of the grouted rip-rap apron to the Arkins Court outfall. Both locations are shown on Figure 5 and sheets 34 and 36 of the record drawings.

**<u>Arkins Court Erosion Repair and Corrective Action</u>**

On June 19 and 24, 2018, heavy stormwater flows through the Arkins Court outfall eroded the open channel immediately downstream from the outfall apron. Erosion removed the seeding blanket and protective soils, and exposed the liner. An approximate 3 foot x 3 foot area adjacent to concrete apron was exposed. A larger area in the same vicinity was also impacted, but the liner was not exposed. The CCD evaluated the event and determined the problem was caused by a combination of flash precipitation events and high flow being temporarily channeled to the Arkins Court outfall while other upstream segments of stormwater system were still under construction.

On July 9, 2018, the CCD proposed design changes to correct the temporary erosion problem, as well as provide a permanent solution to protect against future flooding. It involved installing grouted boulders over the protective soils that overlie the liner. The grouted boulders would begin at the downstream edge of the concrete apron and extend for about 26 feet further downstream. The highly visible orange construction fencing would not be needed beneath the grouted boulders. The boulders would be grouted in place such that their tops would be 3 to 12 inches above channel invert elevation. Additionally, riprap would be placed for fifteen feet downstream of the grouted boulders across the entire channel. The orange construction fencing over the protective soils would be placed beneath all of the rip rap. On July 13, 2018, EPA accepted the design changes.

Before the grouted boulders and rip rap were placed, protective soils were placed and compacted over the exposed liner and a second ELLS test was performed on the liner-exposed and adjacent areas – an approximate 100 x 100 foot area. No leaks were detected. The test report documenting this is presented in Appendix C. The grouted boulders and riprap were placed after the test was complete. Record drawing Sheets 34 and REF 02 (Appendix A) show the completed work.

Due to the erosion events, the grasses along the bottom of the low-flow channel did not establish well due to the relatively high low-flow conditions. Thus, it was decided in September 2018, that replacing the topsoil along the bottom of the low-flow channel (trickle channel) with a layer of void-filled riprap would help establish the wetland grasses. The void-filled riprap would extend for 89 feet beyond the grouted boulders at the Arkins Court outlet. This design change will be implemented in 2019 as part of the next phase of the Park construction. The design drawing detailing this change is presented on Sheet 34 and REF 02 in Appendix A.

# 3 CHRONOLOGY OF EVENTS

The chronology of Removal Action events is grouped into the following three categories:

- Preparing the Administrative Settlement Agreement and Order on Consent;
- Planning, Design, and Procurement; and
- Implementation.

Each category is discussed below.

## 3.1 Administrative Settlement Agreement and Order on Consent

During the first half of 2015, the CCD and USEPA negotiated the SOW and AOC for the Removal Action. The SOW became Appendix C to the AOC. The AOC became effective on July 1, 2015.

Additionally, EPA released the VB/I70 Community Involvement Plan Addendum in June 2016 (EPA, 2016). In this plan, EPA requested that CCD provide a mechanism for stakeholders to get more information or voice concerns. As a result of this request, the EPA, CDPHE, and CCD identified members of the community who desired to participate in a Community Advisory Group (CAG) to monitor progress of the Removal Action. CAG meetings were held monthly throughout the Removal Action. A project hotline was also established for community complaints.

## 3.2 Planning, Design, and Procurement

Because the Removal Action was time-critical, preparation of planning documents began in May 2015, such that design investigations and the design itself could commence as soon as the AOC was authorized. Thus, the following chronology for pre-design documents, design investigations, design reports, and procurement of a construction contractor occurred:

| Document/Planning Activity | Start | Finish |
|---|---|---|
| Removal Action Work Plan | May 2015 | June 2015 |
| Design Investigation | July 2015 | September 2015 |
| Data Summary Report | August 2015 | September 2015 |
| Remediation Discharge Permit | March 2015 | October 2016 |
| Draft Design Report | August 2015 | October 2016 |
| Pre-Final Design Report | October 2015 | December 2015 |
| Final Design Report | December 2015 | March 2016 |
| Materials Management Plan | September 2015 | January 2016 |
| Methane, Odor, and Dust Control Plan | September 2015 | January 2016 |
| Addendum 1 to Data Summary Report | March 2016 | May 2016 |
| Addendum 1 to Final Design Report | June 2016 | August 2016 |
| Addendum 2 to Final Design Report | October 2016 | January 2017 |

| | | |
|---|---|---|
| Procurement through Notice-to-Proceed | August 2016 | December 2016 |

## 3.3 Implementation

The Ames construction contract was awarded in December 2016. Immediately thereafter, Ames began to mobilize. Prior to disturbing the ground surface, and before heavy equipment was brought to the Site, the CCD set up environmental monitoring stations and collected baseline air quality data. Setup and subsequent construction activities followed, as listed below:

| Construction Activity | Start | Finish |
|---|---|---|
| Mobilization and Site Setup | December 2016 | January 2017 |
| Install Grout Columns | January 2017 | April 2017 |
| Install Stone Columns | February 2017 | February 2017 |
| Mass Excavation | January 2017 | August 2018 |
| Transfer of Remediation Discharge Permit to MFEI | March 2017 | March 2017 |
| Dewatering and Treatment | April 2017 | August 2018 |
| Install Additional Sheet Piling South of Dewatering Zones 3a and 3b | September 2017 | September 2017 |
| Addendum 3 to Final Design Report | March 2018 | May 2018 |
| Liner Construction and Testing | March 2018 | April 2018 |
| Final Grading and Seeding | April 2018 | August 2018 |
| Environmental Monitoring | December 2017 | August 2018 |
| Pre-Final Inspection | August 23, 2018 | August 23, 2018 |

Upon completion of the Removal Action, additional "non-environmental" work such as construction of park recreation facilities and trails and parking areas continued. Those activities utilized much of the same heavy equipment and infrastructure that were deployed to construct the Removal Action. Consequently, the construction contractor did not demobilize immediately following completion of the Removal Action.

# 4 PERFORMANCE STANDARDS AND CONSTRUCTION QUALITY CONTROL

Compliance with performance standards and quality control criteria for the Removal Action consisted of the following:

- Assuring that environmental monitoring was performed in accordance with the MODCP (EMSI, 2015d);
- Assuring that excavated materials were managed in accordance with the MMP (EMSI, 2016a);
- Assuring that treatment of Site waters was performed in accordance with CDPHE Discharge Permit Number CO0049002;
- Assuring that compaction grout and stone columns were installed in accordance with Design Plans and Specifications (EMSI, 2016b); and
- Assuring that the impermeable barrier system was installed and tested in accordance with Design Plans and Specifications (EMSI, 2016b).

The means by which the MMP, MODCP, Discharge Permit, and pertinent Design Plans and Specifications were complied with are discussed below.

## 4.1 Compliance with MMP and MODCP

Sixteen Quality Assurance field audits were performed to assess asbestos management compliance with CSWR Section 5.5 and to assess environmental monitoring compliance with the MODCP and MMP. EMSI representatives also conducted spot-check reviews of waste manifests covering waste shipments to DADS.

Audit findings were identified in each report, along with recommendations to correct non-conformances. In all cases non-conformances were corrected to the auditor's satisfaction and the audits were closed. The sixteen audit reports were submitted to EPA as part of monthly Pollution Reports.

## 4.2 Compliance with Discharge Permit

Water treatment at MFEI was monitored for compliance with CDPHE Discharge Permit Number CO0049002. Specifically, limitations on discharge rates to the South Platte River and effluent water quality for all permitted pollutants were monitored independently by EMSI. Monthly influent quality parameters were also monitored. Lastly, EMSI monitored MFEI's electronic reporting (netDMRs) of influent and effluent data to CDPHE, as required by the discharge permit.

With five exceptions, all monitoring requirements were complied with and discharge limits were met. The exceptions are listed below:

- In April, 2017, an initial whole effluent toxicity (WET) test result failed because of spontaneous toxicity. This occurred when MFEI was blending plant effluent with potable water from Denver Water to meet nitrate limits. The failure triggered a need for additional acute testing. MFEI then conducted a series of acute tests on potable water alone, plant effluent blended with potable water, and plant effluent alone. The first two samples failed, while the third passed. MFEI concluded that the potable water containing chlorine was the source of the toxicity. MFEI then reconfigured the treatment train to use reverse osmosis for nitrate removal instead of potable water blending. With reverse osmosis online, they re-performed the WET testing, and passed. Since then, nitrate removal was accomplished with reverse osmosis treatment.
- In October 2017, potentially dissolved selenium in plant effluent exceeded its performance standard. The treatment plant operator confirmed that plant operating parameters prior to and during the sampling event were within normal operating ranges, and that sampling procedures, preservation, chain of custody, and delivery procedures were followed exactly as in the past. CDPHE was notified of the exceedance and agreed that the detection was anomalous. CDPHE also recommended continued operation of the plant in accordance with standard operating procedures. No further action was required.
- In March 2018, E-coli was detected in plant effluent above its performance standard. The exceedance was attributable to insufficient chlorine contact time while the treatment plant was down for the Easter holiday. When operations resumed after the holiday, the stagnant effluent was pumped out and sampled. To prevent a recurrence, the plant operator proposed that if the plant was down for more than two days, additional chlorine would be added to the effluent surge tank, the tank would be drained at shut-down, or stagnant effluent would be reprocessed through the plant prior to discharge. CDPHE accepted the corrective measures. No further action was required.
- In June 2018, a monthly report was filed late. Internal protocol to prevent a recurrence was established and no further action was required.
- In August 2018, the fourth weekly sample for total suspended solids and E-coli analyses was collected, but inadvertently not analyzed. The operator notified CDPHE of the error. Plant operations had been following standard operating procedures and influent sources were the same as previous weeks, so discharge limits were likely met. MFEI properly reported the violation to CPDHE and took appropriate action to prevent a recurrence. CDPHE did not require further action.

All of these issues have been resolved to the satisfaction of CDPHE and EPA. There are no outstanding violations.

### 4.3 Compliance with Design Documents for Grout and Stone Columns

Quality control testing of the compaction grout and stone columns was performed by Ames' QC contractors in accordance with the Design Documents. QC testing for the compaction grout columns was provided by Ground Engineering Consultants, Inc., who was an independent testing firm. Their results were provided to Ames and Kiewit for review and approval. A letter documenting their testing program is provided in Appendix C. QC monitoring and certification that the stone columns were installed in accordance with the design documents were provided by Hayward Baker. A letter certifying compliance is presented in Appendix C.

### 4.4 Compliance with Design Documents for Impermeable Barrier System

Quality control testing of materials used for the impermeable barrier system was performed by material suppliers, then reviewed and independently tested by Amec Foster Wheeler. Testing certifications were also reviewed by Kiewit and R.K. Frobel to confirm compliance. Similarly, compaction testing of subgrade soils and overlying protective soils was performed by a construction quality assurance firm retained by Ames. Compaction results were reviewed by Kiewit and R.K. Frobel to confirm compliance.

Installation of the liner components was performed by ECApplications, Inc. a specialty contractor experienced with liner installations. Placement of the liner components and testing of liner welds were monitored Amec Foster Wheeler and reviewed by Kiewit and R.K Frobel. The work conformed to construction specifications. Lastly, ELLS testing of the liner with overlying protective soils in place was conducted by Leak Locations Services, Inc. Testing results confirmed liner integrity. A CQA report detailing quality control monitoring and testing is presented in Appendix C of this report.

As part of the erosion repair work performed at the Arkins Court outfall (discussed in Subsection 2.6 of this report), a second ELLS test was performed on the liner and overlying soils in the disturbed area (Appendix C). No leaks were detected.

## 5 FINAL INSPECTION AND CERTIFICATIONS

A Pre-Final Inspection occurred on August 23, 2018 that was attended by EPA, CDPHE, and the CCD. Items inspected consisted of:

- Completion of waste material removal and disposal for liner installation and over-excavation of the arsenic and lead soils that exceeded cleanup action levels per the Final Design Report, Addendum 2 (EMSI, 2016d);
- Completion of dewatering and waste disposal prior to liner installation;
- Completion of liner installation, including ELLS testing and access to testing wires;
- Seeding and erosion protection in main open channel, and outlet channel;
- Sheet piles along south side of open channel remain in place;
- CABI and environmental reports are available;
- DMRs are available;
- Waste manifests are available; and
- Review of the draft Globeville Landing Outfall Environmental Monitoring and Maintenance Plan (GLOEMMP).

The following punch-list items were identified:

- Barrier system installation: The construction quality assurance reports (Appendix C) needed to be reviewed and approved by EPA.
- Water Treatment Plant Permit Compliance: EPA's Enforcement and Compliance History Online (ECHO) report indicated the MFEI facility had been in violation since October 2016.
- Waste manifests: Many waste manifests had incomplete information.
- Monitoring and Maintenance Plan: EPA was reviewing the GLOEMMP.

These punch-list items have been addressed as follows:

**5.1 Barrier System Installation:** A conference call was held on September 6, 2018, to discuss EPA's comments on the electrical leak location reports for both the April and July surveys. Following that conversation, EPA approved the May electrical leak location report. The July report was revised and resubmitted to EPA on September 10, 2018 (Appendix C).

**5.2 Water Treatment Plant Permit Compliance:** As discussed in Section 4.2, five non-compliance events occurred during the Removal Action. All have been resolved.

**5.3 Waste Manifests**: Some waste manifests did not have waste quantities listed. Others had incomplete generator, transporter, and/or date information. Causes for these non-conformances were: 1) some pre-printed manifests from Waste Management of Colorado, Inc. had not been fully completed prior to use by Ames; 2) truck drivers and/or foreman did not know what information to include; and 3) foremen did not check manifests for completion prior to trucks departing the GLO site. Solutions consisted of: 1) having foremen fill in waste quantities if they were not pre-printed; 2) having foremen require truck drivers fill out generator, transporter, and date information on the manifests prior to departing the site; and 3) having foreman check manifests for completeness, then give truck drivers 4 copies of the manifest, retaining one. On July 18, 2018, a Corrective Action Report (CAR) listing these causes and solutions was issued by Kiewit. It is presented in Appendix C. Following issuance of the CAR, CCD and EMSI independently verified proper completion of waste manifests. Documentation of this QA step was provided in QA Audit reports that were attached to monthly Pollution Reports. Compliance was achieved and no further corrective action was required.

**5.4 Globeville Landing Outfall Environmental Monitoring and Maintenance Plan:** The GLOEMMP was prepared by CCD to address Post-Removal Site Control as outlined in Section 27 of the AOC. The Plan outlines monitoring and maintenance requirements for the impermeable barrier system installed within the GLO open channel segment, including piezometers used for monitoring groundwater levels adjacent to the channel and sheet pile wall south of the channel. The goal of the GLOEMMP is to define the work tasks, including inspections, maintenance activities and performance validation measures needed to ensure that the impermeable barrier system continues to prevent contaminated media from adversely impacting storm water conveyed by the drainage system and prevents storm water infiltration into contaminated media remaining beneath and contiguous to the open channel boundaries. The GLOEMMP was accepted by EPA on December 13, 2018.

## 6 SUMMARY OF ESTIMATED PROJECT COSTS

Estimated Removal Action costs are summarized below:

| Estimated Costs - Environmental Components of the GLO Project (2015 through September 2018) | Total |
|---|---|
| Environmental Characterization and Design of the Impermeable Barrier System | $ 312,308 |
| Management and Disposal of Waste Material | $ 8,786,262 |
| Construction of the GLO Open Channel and Impermeable Barrier System | $ 2,791,102 |
| Water Treatment | $ 5,504,848 |
| Air, Methane, Odor and Dust Monitoring | $ 525,338 |
| Contractor Oversight | $ 817,776 |
| Environmental Permit Fees | $ 3,780 |
| EPA Oversight Reimbursements | $ 256,384 |
| Community Outreach | $ 81,053 |
| CCD Oversight | $ 388,616 |
| **Sum** | **$ 19,467,467** |

## 7 OPERABLE UNIT CONTACT INFORMATION

The following contact information is provided for key members of the Removal Action team:

**CCD:**

Ms. Agatha Linger
Denver Department of Public Health and Environment
City and County of Denver
101 West Colfax Avenue, Suite 800
Denver, CO 80202
720-865-5356
Agatha.Linger@denvergov.org

**Managing Contractor:**

Mr. Timothy C. Shangraw, P.E.
Engineering Management Support, Inc.
25923 Gateway Drive
Bolden, CO 80401
303-619-5179
TimShangraw@EMSIDenver.com

**Liner Design and CQA Officer:**

Mr. Ronald K. Frobel, P.E.
Consulting Engineer
32156 Castle Court, Suite 211/M240
Evergreen, CO 80439
303-679-0285
geosynthetics@msn.com

**Construction Contractor:**

Mr. Travis Davis
Ames Construction
18450 E. 28th Ave.
Aurora, CO 80011
303-363-1000
TravisDavis@amesco.com

**Water Treatment Subcontractor:**

Mr. Scott McDonald
McDonald Farms Enterprises, Inc.
4647 National Western Drive
Denver, CO 80216

303-981-6839
mcfarms2@aol.com

**EPA Remedial Project Manager**

Mr. Jesse Aviles
Environmental Protection Agency
Mailcode: OEPR-SR
1595 Wynkoop Street
Denver, CO 80202-1129
303-312-6287
aviles.jesse@epa.gov

**CDPHE Project Manager**

Mr. Fonda Apostolopoulos, P.E.
Colorado Department of Public Health and Environment
4300 Cherry Creek Drive South
Denver, CO 80246
303-692-3411
Fonda.Apostolopoulos@State.co.us

# 8 REFERENCES

Engineering Management Support, Inc. (EMSI), 2015a. Final Removal Action Work Plan, High Street Outfall and 40th Avenue Storm Sewer System, Vasquez Boulevard/Interstate 70 Site, Operable Unit #2, prepared by Engineering Management Support, Inc., June 19, 2015.

EMSI, 2015b. Health and Safety Plan for the Removal Action, High Street Outfall and 40th Avenue Storm Sewer System, Vasquez Boulevard/Interstate 70 Site, Operable Unit #2, prepared by Engineering Management Support, Inc., June 19, 2015.

EMSI, 2015c. Data Summary Report, Environmental Conditions Investigation High Street Outfall and 40th Avenue Storm Sewer System, Vasquez Boulevard/Interstate 70 Site, Operable Unit #2 Removal Action, September 18, 2015.

EMSI, 2015d. Final Methane, Odor, and Dust Control Plan, Globeville Landing Outfall Project, prepared by Engineering Management Support, Inc., December 15, 2015.

EMSI, 2016a. Final Materials Management Plan, Globeville Landing Outfall Project, prepared by Engineering Management Support, Inc., January 25, 2016.

EMSI, 2016b. Final Design Report, Environmental Components for Globeville Landing Outfall Project, prepared by Engineering Management Support, Inc., R.K. Frobel & Associates, LLC, and Itasca Denver, Inc., February 5, 2016.

EMSI, 2016c. Addendum 1 to Data Summary Report, Environmental Conditions Investigation High Street Outfall and 40th Avenue Storm Sewer System, Vasquez Boulevard/Interstate 70 Site, Operable Unit #2 Removal Action, March 15, 2016.

EMSI, 2016d. Addendum 1 to Final Design Report, Environmental Components for Globeville Landing Outfall Project, prepared by Engineering Management Support, Inc. and Itasca Denver, Inc., August 5, 2016.

EMSI, 2016e. Addendum 2 to Final Design Report, Environmental Components for Globeville Landing Outfall Project, prepared by Engineering Management Support, Inc., November 28, 2016.

EMSI, 2018a. Addendum 3 to Final Design Report, Environmental Components for Globeville Landing Outfall Project, prepared by Engineering Management Support, Inc., April 12, 2018.

USEPA, 2015. Administrative Settlement Agreement and Order on Consent for Removal Action in a Proceeding Under Sections 104, 106(a), 107 and 122 of the Comprehensive Environmental Response, Compensation, and Liability Act, 42 U.S.C. §§ 9604, 9606(a), 9607 and 9622 regarding the Vasquez Boulevard/Interstate 70 (VB/I70) Site Operable Unit, July 1, 2015.

USEPA, 2016. Community Involvement Plan Addendum For the Removal Action at Operable Unit 2 (OU2) – Former Omaha & Grant Smelter Location– Globeville Landing Outfall Project, Vasquez Boulevard & Interstate 70 (VB/I-70) Superfund Site, June 2016.

## FIGURES

**Figure 1 Site Location Map**

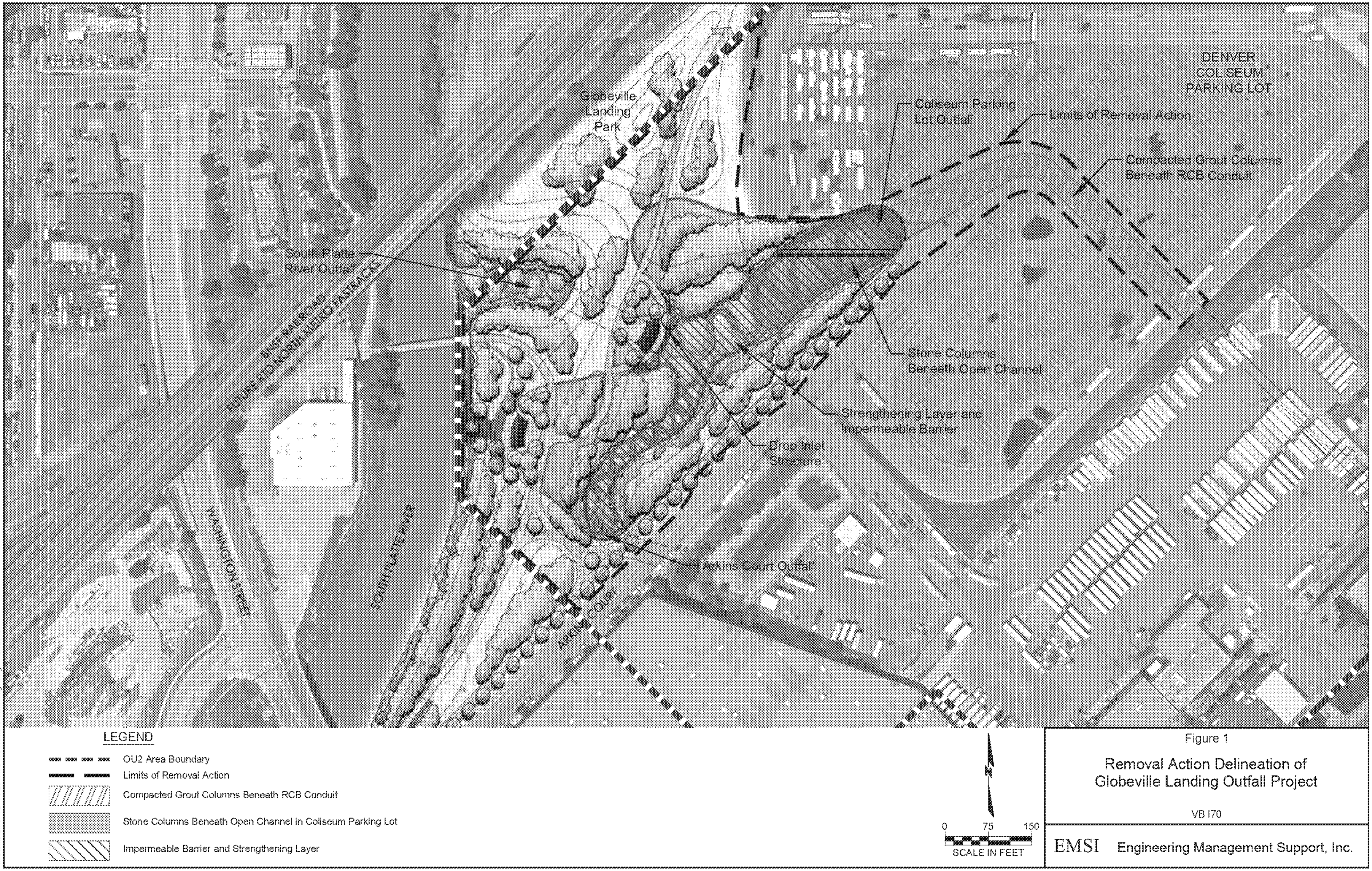


Figure 1

Removal Action Delineation of Globeville Landing Outfall Project

VB I70

EMSI Engineering Management Support, Inc.

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**Figure 2  Organization Chart**

**Figure 2**
**Organization Chart**
**VB/I70 Operable Unit 2 Removal Action Implementation**

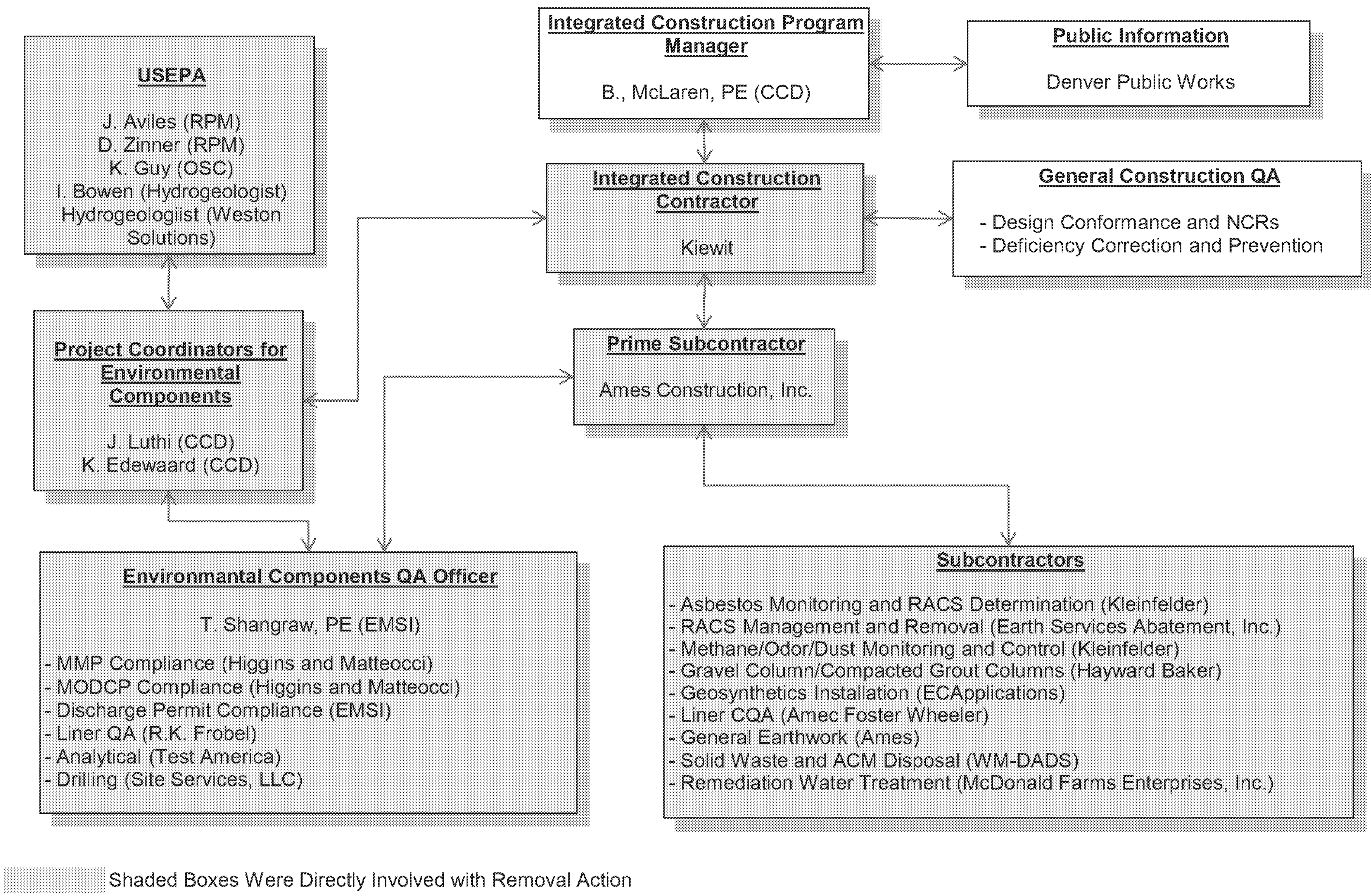


**Figure 3 Areas of Over-Excavation**

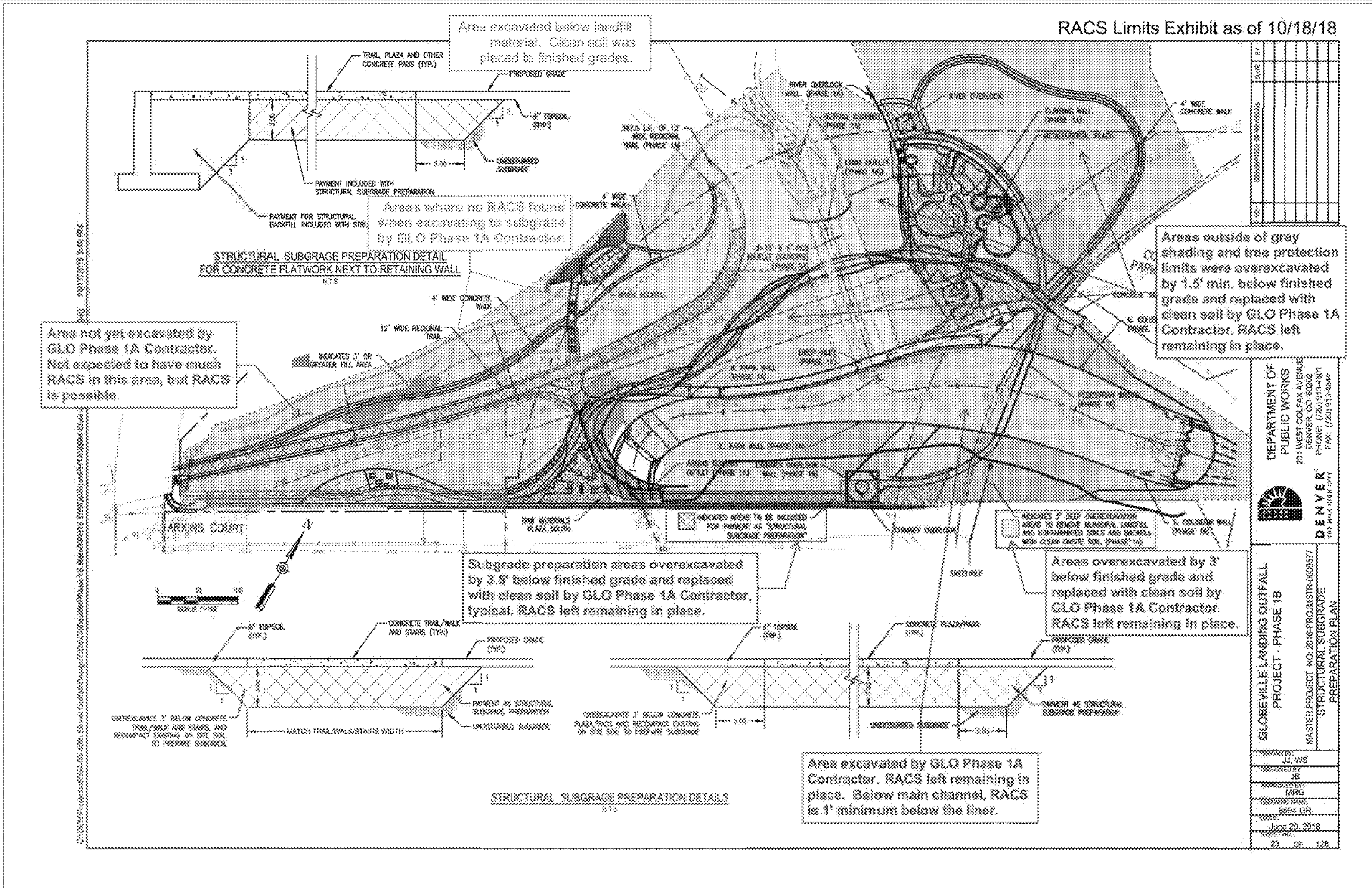


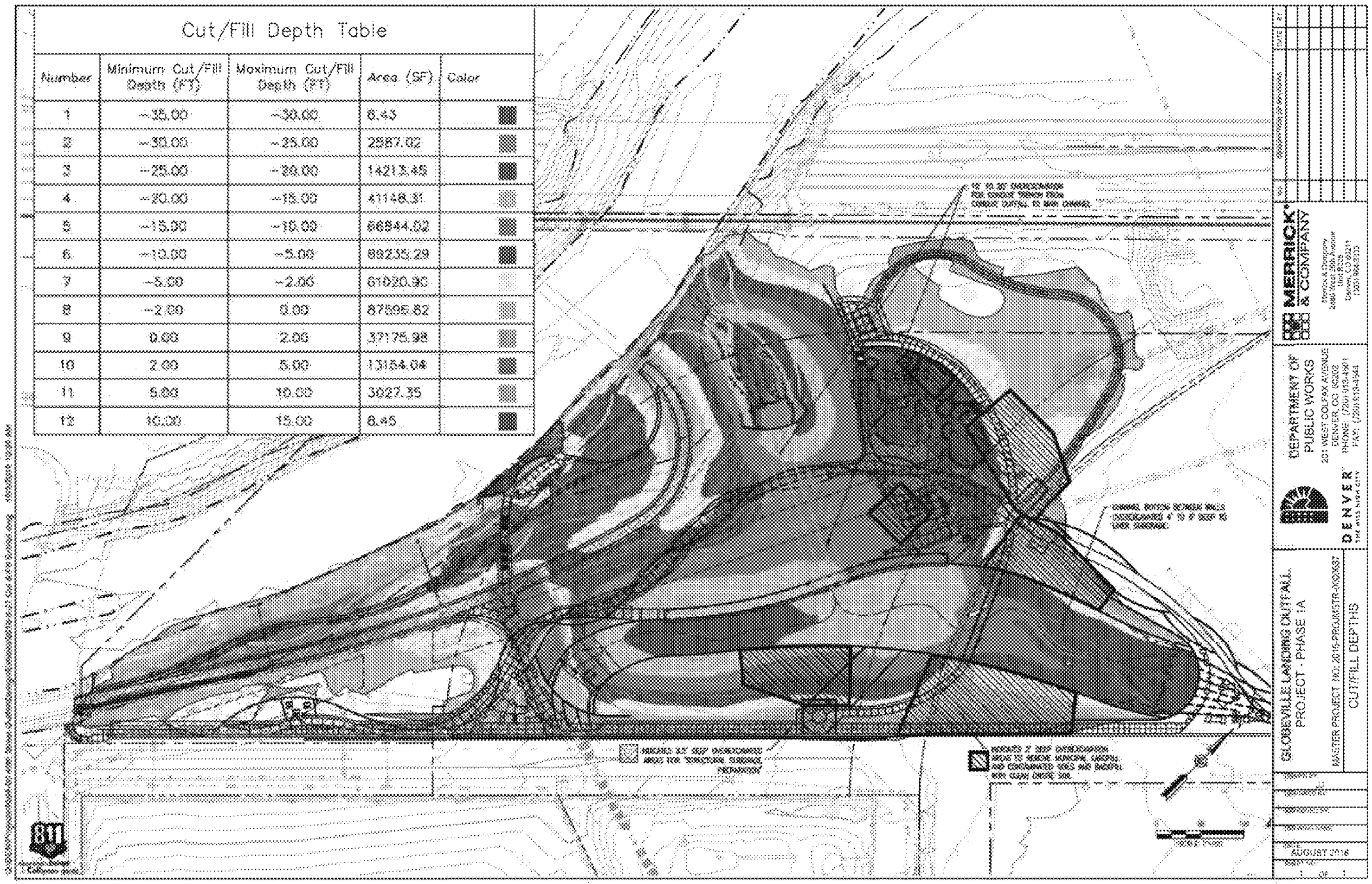

Figure 3

Areas of Over-Excavation
Globeville Landing Outfall Project

VB I70

EMSI Engineering Management Support, Inc.

**Figure 4  Cut and Fill Summary**




## Cut/Fill Depth Table

| Number | Minimum Cut/Fill Depth (FT) | Maximum Cut/Fill Depth (FT) | Area (SF) | Color |
|---|---|---|---|---|
| 1 | -35.00 | -30.00 | 6.43 | |
| 2 | -30.00 | -25.00 | 2587.02 | |
| 3 | -25.00 | -20.00 | 14213.49 | |
| 4 | -20.00 | -15.00 | 41148.31 | |
| 5 | -15.00 | -10.00 | 66844.02 | |
| 6 | -10.00 | -5.00 | 89235.29 | |
| 7 | -5.00 | -2.00 | 61020.90 | |
| 8 | -2.00 | 0.00 | 87595.62 | |
| 9 | 0.00 | 2.00 | 37175.98 | |
| 10 | 2.00 | 5.00 | 13154.04 | |
| 11 | 5.00 | 10.00 | 3027.35 | |
| 12 | 10.00 | 15.00 | 6.45 | |

0 75 150
SCALE IN FEET

Figure 4

Cut and Fill Summary
Globeville Landing Outfall Project

VB I70

EMSI Engineering Management Support, Inc.

**Figure 5 Sheet Piling Alignment and Access to ELLS Testing Wires**


LEGEND

- OU2 Area Boundary
- Limits of Removal Action
- Sheet Piling Alignment
- Compacted Grout Columns Beneath RCB Conduit
- Impermeable Barrier and Strengthening Layer
- Stone Columns Beneath Open Channel

0 75 150
SCALE IN FEET

Figure 5

Sheet Piling Alignment and Access to ELLS Testing Wires

VB I70

EMSI Engineering Management Support, Inc.